Ea Energianalyse

January
2023

Impact analysis of the Paris Agreement on Greenlandic society

Main Report

This report has been drawn up by Ea Energianalyse for the Ministry of Agriculture, Self-Sufficiency, Energy and Environment.

The analysis has been organised in two reports: A main report (this document) and a background report which looks at the relevant themes in greater depth.

The report is originally published in Danish and translated to English by the Ministry of Agriculture, Self-Sufficiency, Energy and Environment.

Ea Energianalyse
Gammeltorv 8, 6 tv.
1457 København K
www.eaea.dk

Contents

Background and main conclusions	**4**
Background and purpose	4
Main conclusions	5
Climate change and the Paris Agreement	**6**
Global climate change	6
How does climate change affect Greenland?	6
The Paris Agreement	7
How is Greenland bound by the Paris Agreement?	7
Carbon footprint and potential for reduction	**8**
Greenland's carbon foorprint in 2020	8
Initiatives commenced	9
Carbon footprint forecast	10
Green fuels	11
Sector challenges	**12**
Recovery of mineral resources	12
Shipping and fishery	13
Other commercial perspectives	14
References	**15**

1

Background and main conclusions

Background and purpose

In order to reduce the negative impact of climate change, 195 of the world's countries adopted the Paris Agreement in 2015. The agreement contains a commitment to ensuring that the rise in global temperature is kept some way below 2° C in relation to pre-industrial levels and a call to action that can limit the temperature increase to 1.5° C. The countries concerned have legally bound themselves to work towards meeting these targets.

Denmark adopted the Paris Agreement in 2016 subject to a so-called territorial reservation for Greenland. This was due to the Government of Greenland at the time requesting such a reservation, the primary reasons for which were concerns that economic development in Greenland could be held back by climate considerations and that the agreement did not contain a legally binding reference to the rights of indigenous peoples or the right to development for indigenous peoples. Greenland's parliament must decide on whether this territorial reservation is to be revoked, thereby resulting in Greenland officially adopting the Paris Agreement. As such, the coalition agreement from 2022 between the two government parties, Inuit Ataqatigiit and Siumut, declared as follows:

An analysis must be conducted of the consequences of the Paris Agreement for society. This analysis is to be presented for debate no earlier than during the autumn 2022 session of parliament.

Based on the coalition agreement, an analysis has been carried out here with the following objectives:

1. To examine how the Paris Agreement will have an impact in terms of Greenland's obligations, and
   To analyse what needs to be done so that Greenlandic society can reduce its impact on the climate.

Main conclusions

Regarding the Paris Agreement and climate change

- Greenland is not an independent party with respect to the UN's climate convention. Greenland cannot therefore report a separate reduction contribution to the UN under the terms of the Paris Agreement. Reduction contributions and climate actions must be forwarded via Denmark. A potential model would be to communicate separate Greenlandic climate action as a supplement to the Danish commitment to the Paris Agreement.
- The Legal Adviser to the Danish Government deems that:
  In collaboration with the Danish government, Greenland will (...) have to determine how, in separate climate action, it will contribute to meeting obligations under the terms of the Paris Agreement. This collaboration will be based on legislation on self-government and the cooperation agreement between the Danish government and the Government of Greenland concerning international climate change under the UN's climate convention, including the fact that Greenland has taken over the area of climate. There is thus no legal hindrance preventing Greenland – in collaboration with the Danish government – from setting a reduction target that is different to that to which Denmark has committed itself in the EU-NDC. In this regard, areas such as mineral resources and the maritime sector will be able to be excluded from any reduction obligations for Greenland.
- According to the UN's climate panel, there is a high level of probability that climate change will lead to significant changes in Greenland and the Arctic, including greater melting of the Ice Sheet, thawing of the permafrost, smaller areas of sea ice, increased risk of landslides and subsequent destructive tidal waves, a rise in sea level and the extinction of animal species.

Regarding Greenland's carbon footprint and the green transition

- In 2020, Greenland's national CO_2 emissions stood at 577,000 tonnes of CO_2 equivalents and stem primarily from the burning of oil products for heating, fishery, electricity production and transport. Emissions today are 12% lower than in 1990.
- Previously commenced initiatives concerning the expansion of hydropower (Utoqqarmiut Kangerluarsunnguat near Nuuk and Kuussuup Tasia near Qasigiannguit and Aasiaat) will reduce the consumption of oil to produce electricity and heat. This can reduce Greenland's emissions to approx. 460,000 tonnes (30% lower than in 1990), depending on how the hydropower is utilised.
- Increased activity from the recovery of minerals and mining operations can potentially increase Greenland's carbon footprint. Calculations reveal that if all exploitation licences end up as fully-fledged mines and the projects are based on fossil fuels, this may lead to an increase in Greenland's carbon footprint by 40% compared to 2020. It should be noted that there is a focus on the potential of a renewable energy supply for mining projects and other measures to reduce CO_2. Furthermore, it is difficult to estimate which projects will be implemented and whether their periods of operation will coincide.
- In terms of industrial policy, a marked shift is currently underway in the international arena, which is seeing demand for production that takes climate change into consideration. The green transition of production is regarded by several operators as a competitive parameter.
- The greatest challenges for Greenland in relation to finding climate solutions involve adapting fishery, shipping, aviation and energy consumption in towns and settlements without access to hydropower.

2

Climate change and the Paris Agreement

Global climate change

CO_2 content in the atmosphere is increasing

The concentration of greenhouse gases in the atmosphere is at its highest level for 800,000 years. Greenhouse gases such as CO_2 and methane affect the climate on Earth by blocking the radiation of heat that is reflected from the surface of the planet, whilst the influx of radiation from the sun is not hindered. The high concentration of CO_2 has resulted in the Earth now being approximately 1.1° C warmer than pre-industrial levels (1850-1900).

Consequences of global warming

According to the UN climate panel, climate change is due to human behaviour, which includes the burning of fossil fuels such as coal, gas and oil. Increases of temperature on a global scale will in all likelihood mean more frequent extreme weather phenomena, intense droughts, heatwaves, water shortages, serious fires, rising sea levels, floods, melting of ice at the poles, greater spread of disease, catastrophic storms and loss of biodiversity. (IPCC, 2022)

Target of max. 1.5° C increase is crucial

UN climate researchers (IPCC) estimate that limiting the global increase in temperature to no more than 1.5° C is crucial in preventing the worst irreversible impacts on the climate, i.e. climate change which humanity cannot make good again. Scientists are therefore warning that the world can reach a "point of no return" where we can no longer control warming. Net emissions to the atmosphere continue to grow and even with the climate plans that have been announced, a total increase of 2.1-2.9° C in mean temperature is expected by 2100. (UNFCCC, 2022)

How does climate change affect Greenland?

Since 1997 the amount of ice on the Ice Sheet has declined. A total of around 84 billion tonnes of ice

melted in 2021/2022, which raised sea levels by approx. 0.2 millimetres in 2021 alone. The melting of the Ice Sheet sees some natural variation, but it has been losing mass every year since 1997. The acceleration in melting of such large masses of ice causes global sea levels to rise. According to UN climate researchers, the following events will occur with medium, high or very high levels of probability in Greenland and the Arctic:

- Thawing of permafrost
- Reduction in the area of sea ice
- Rising sea levels
- Flooding and landslides, and subsequent destructive tidal waves
- Extinction of a number of land-based and sea-based animal species
- Damage to and loss of Arctic cultural heritage sites (IPCC, 2022)

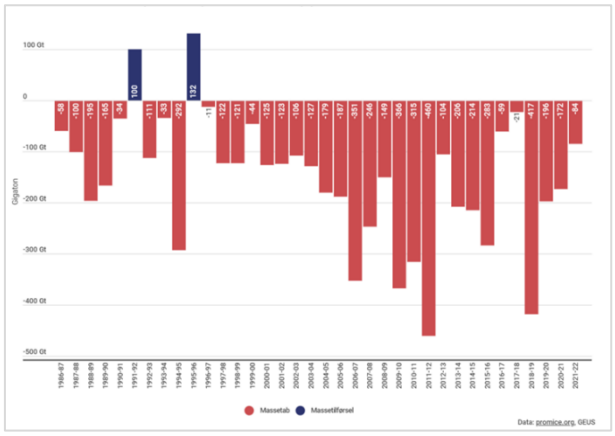


Figure 1. Melting of the Ice Sheet 1986-2022. The mass of ice lost and added respectively every year since 1986. The figure is calculated in melting years, i.e. one melting season and one winter season (1 Sept.-31 August) and shown in billion tonnes (Gt) as an estimate rounded up or down. Source: GEUS

The Paris Agreement

The Paris Agreement was adopted in 2015 by 195 countries at COP21 in Paris and contains a legally binding agreement on limiting global temperature increases and reporting reduction contributions.

More specifically, the parties to the agreement legally commit themselves to the following:

a) keeping the mean global increase of temperature to well below 2° C in relation to pre-industrial levels and working to limit the temperature increase to 1.5° C
b) increasing capability to adapt to the negative effects of climate change and promote resistance, and
c) directing the flow of funds towards the transition to low-emission society and climate-robust development.

Furthermore, the parties have an obligation to draw up, announce and maintain ambitious, nationally determined contributions with a view to meeting the targets of the agreement. The Paris Agreement entails that all parties must report or rereport a contribution to reduction every 5 years.

Other main elements in the Paris Agreement include:

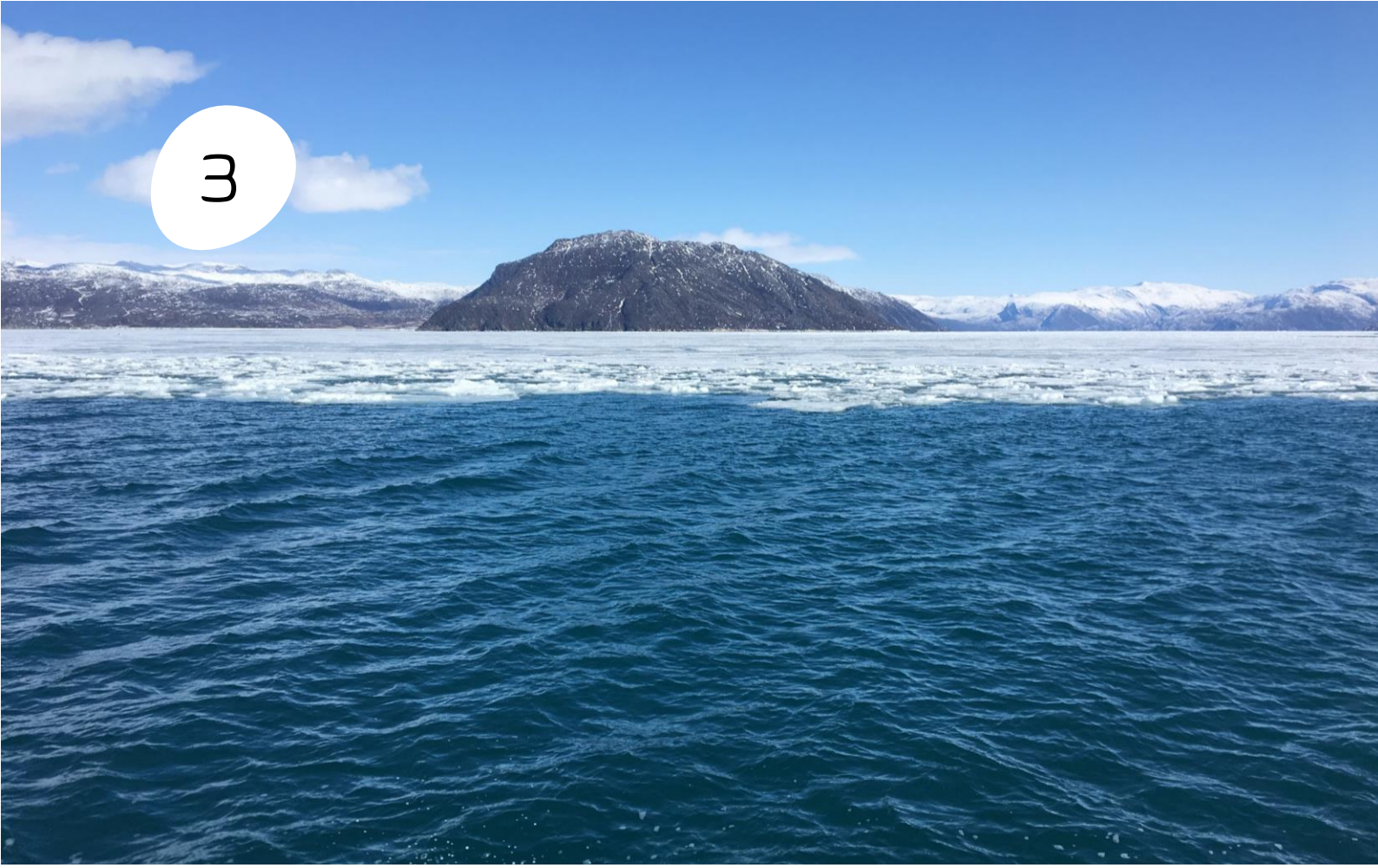
- A goal that global emissions will reach a peak as soon as possible
- A mechanism whereby reported reduction targets will become increasingly ambitious
- Greater transparency regarding global emissions and a universal method of accounting
- Up until 2025, industrial nations will make a commitment to mobilise USD 100 billion in climate funding to developing countries every year
- A goal of communicating the planning and implementation of climate adaptation measures every second year
- Every 5 years the UN monitors whether the parties are 'on track' to achieving the overall goals in the Paris Agreement

How is Greenland bound by the Paris Agreement?

In order to assess Greenland's obligations should the territorial reservation be revoked, Poul Schmith/Legal Adviser to the Danish Government has evaluated Greenland's legal obligations that will result from annulment of the Paris Agreement's territorial reservation. (See background report for further elaboration)

In overall terms, the Legal Adviser to the Danish Government deems that:

- Greenland can communicate a separate Greenlandic reduction contribution as a supplement to the Danish obligation
- In legal terms, there is nothing preventing Greenland from reporting a different reduction commitment than Denmark
- Greenland can exempt certain sectors from reduction commitments, such as the recovery of mineral resources and the shipping sector.



3

Carbon footprint and potential for reduction

Greenland's carbon footprint in 2020

Greenland's national carbon footprint was 577,000 tonnes of CO_2 equivalents in 2020, corresponding to 10.2 tonnes per capita.

Greenland's CO_2 emissions stem primarily from the consumption of oil products in fishery, transport, heating and electricity production. The consumption of oil resulted in a total emission of 533,000 tonnes of CO_2 in 2020. In addition to energy consumption, approx. 44,000 tonnes of CO_2 were emitted from waste management (not incineration), industrial processes and other sources. The emissions from energy consumption appear in figure 2.

In 2020, 82% of the total energy consumption came from oil products (primarily diesel, aviation fuel and petrol), whilst the remaining 18% of energy consumption came from hydropower and incineration of waste.

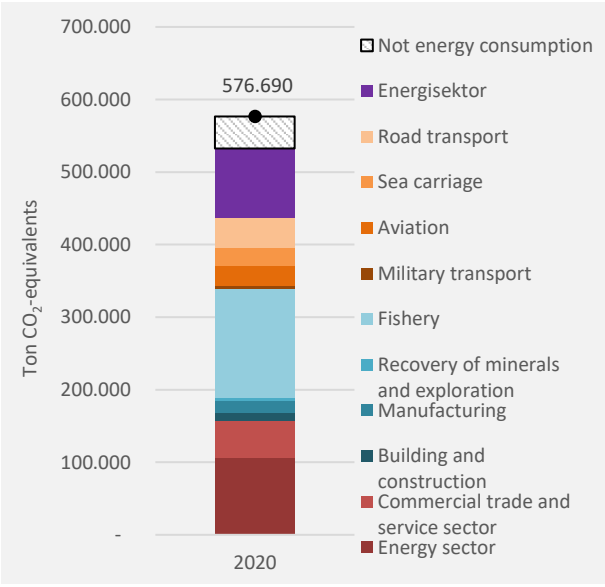


Figure 2. Greenland's CO_2 emissions in 2020. Source: Statistics Greenland

28% of emissions come from fishery, 20% come from heating of households, 16% from energy production (primarily diesel for electricity production) and approx. 16% from different modes of transport.

In 1990, CO_2 emissions totalled 653,000 tonnes. Since that time, the carbon footprint has varied and peaked in 2011 at 762,000 tonnes, when exploration for oil was at its highest. Today annual CO_2 emissions are around 12% lower than in 1990, which is primarily due to the fact that a large portion of public electricity supply comes from hydropower today.

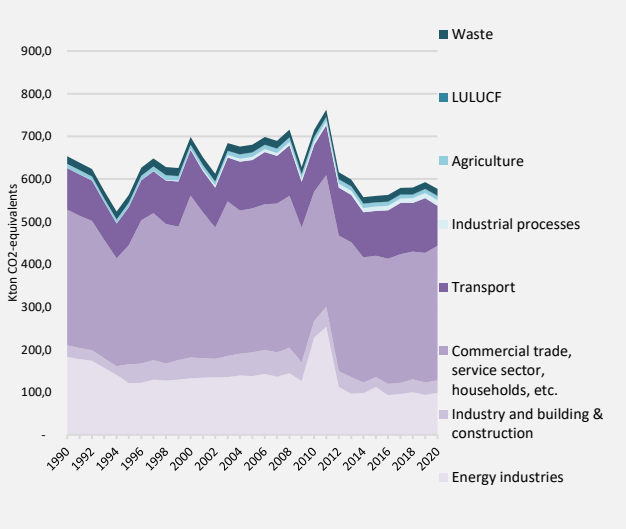


Figure 3. The development of Greenland's emission in CO_2 equivalents from 1990-2020 for energy consumption, industry, waste and agriculture/land use. LULUCF stands for 'Land Use, Land Use Change and Forestry'. Source: UNFCCC reporting.

Initiatives commenced

Reducing Greenland's carbon footprint requires alternatives to oil consumption to be found. Hydropower can potentially supply cheap power from renewable energy sources, and it is therefore likely that the cheapest green solutions involve the electrification of as much of the oil demand in towns where hydropower is available. This entails initiatives such as the conversion of oil heating to electric heating, the replacement of conventional vehicles with electric vehicles, land-based power to ports, etc.

Of the already commenced initiatives that with a high degree of probability will reduce Greenland's emission of greenhouses gases, the following can be highlighted:

- Expansion of Utoqqarmiut Kangerluarsunnguat hydropower plant in Nuuk. Expansion will ensure that private oil heaters in Nuuk can be converted to interruptible electric heating, and that future electricity and heating needs in Nuuk can be met by hydropower.
- Construction of Kuussuup Tasia hydropower plant for the supply of Qasigiannguit and Aasiaat. This will mean that current oil-based electricity production can be replaced by hydropower, and a percentage of private oil heaters can be converted to interruptible electric heating.
- Ongoing development of renewable energy in other towns and settlements, including expansion with solar cells and batteries (hybrid systems). Solar cells and hybrid systems will contribute with oil savings for electricity production in towns and settlements that do not have direct access to supply by hydropower.
- Further conversion of oil heating to electric heating in towns where hydropower is available. In the hydropower towns in which capacity is available at the hydropower plant, work is being carried out to ensure that more private oil heaters can be converted to interruptible electric heating and that large oil boilers in the fishing industry (e.g. in Ilulissat) be converted to electric boilers.
- Upgrading of the charging infrastructure for electric vehicles in towns where hydropower is available. Work is being carried out with regard to subscription solutions and setting up more charging stations.
- Renewable energy at Tussas' radio chain stations.
- New Atlantic airports which will reduce the need for internal feeder traffic.

Carbon footprint forecast

An analysis has been carried out of which adopted initiatives and known means can contribute to the reduction of greenhouse gas emissions in Greenland. The analysis is based on figures from the Ministry of Agriculture, Self-Sufficiency, Energy and Environment and acts as an indication of the significance of different initiatives. Initiatives and means are broken down into two types:

- **Commenced initiatives:** Expansion of hydropower plants and new Atlantic airports.
- **Initiatives in planning phase:** Further increase of hydropower capacity, full exploitation of the hydropower plant in Ilulissat, and hybrid utility supply systems consisting of solar power and batteries (and possibly wind) and diesel generators in the remaining towns supplied by oil and in all settlements. Development of charging infrastructure and more electric vehicles in towns supplied by hydropower.

With the initiatives already commenced concerning the expansion of hydropower and new Atlantic airports, CO_2 emissions can be reduced by approx. 20% in relation to the 2020 figure. This corresponds to a reduction of 118,000 tonnes CO_2, such that total emissions will fall to 459,000 tonnes CO_2. It is deemed that if all the initiatives that are currently being planned are realised, CO_2 emissions can be reduced by almost 40% in relation to 2020 (46% in relation to 1990), with total emissions falling to 350,000 tonnes CO_2.

The remaining 350,000 tonnes CO_2 will have to be found through green shipping and land transport, airports and the energy consumption of building & construction firms, manufacturing companies and others. In this case, direct electrification presents a challenge and there may be a need for a transition to green fuels, including e-fuels.

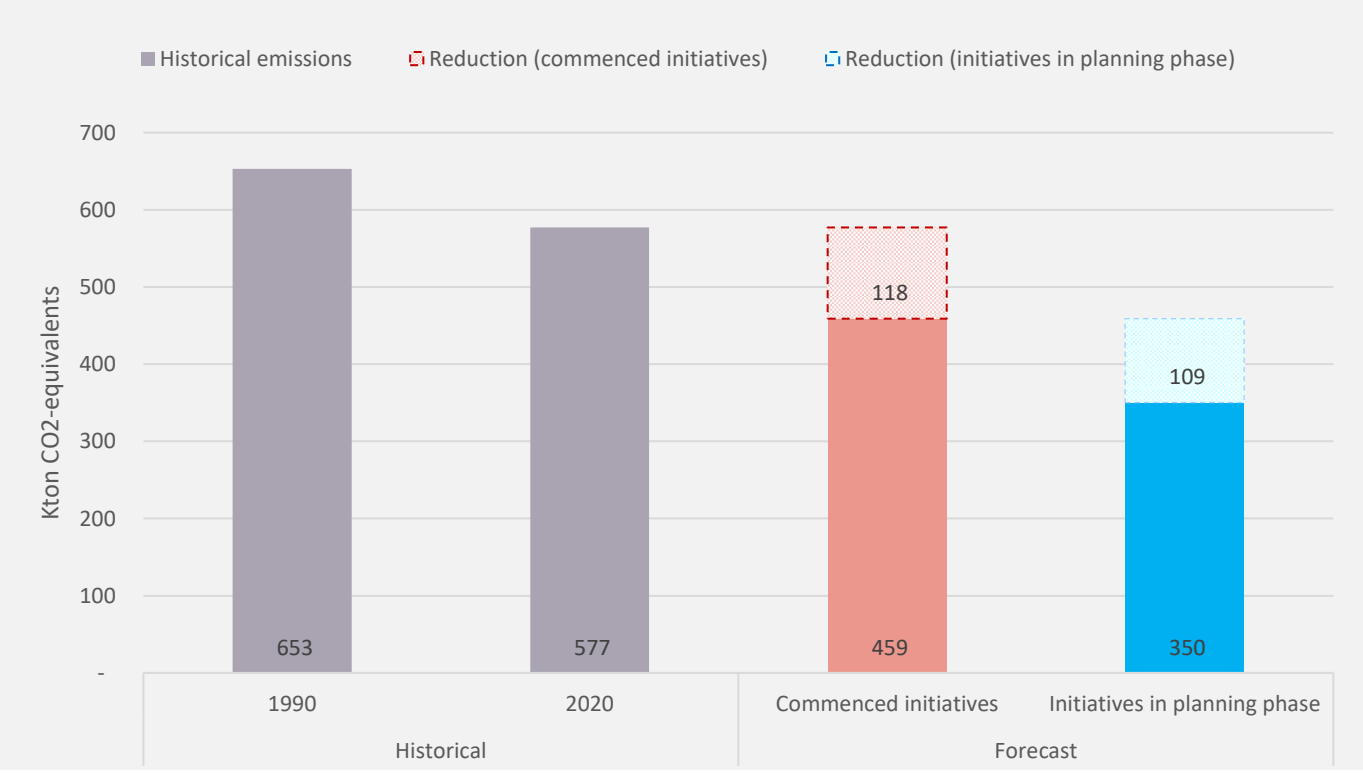


Figure 4. Greenland's historical CO_2 emissions and forecast of Greenland's carbon footprint with two types of initiatives. Source: Ea Energianalyse

Green fuels

Potential green fuels for shipping, electricity production, heating and aviation, etc., include:

- Biofuels from sustainable biomass
- Biomethane/bio-LNG[1]
- Biomethanol
- E-fuels (Power-to-X) based on renewable electricity and biogenic CO_2
    - E-hydrogen
    - E-methanol
    - E-ammonia
    - E-diesel

E-fuels (Power to X)

There is currently a great deal of international focus on fuels produced by so-called Power-to-X (PtX) technology (also called electrofuels or e-fuels). PtX is an umbrella term for fuels which are produced from hydrogen. Hydrogen can be produced from green power (including hydropower) by means of electrolysis and the hydrogen can then be used to produce a number of fuels, including methane, methanol, ammonia or diesel-like products. More and more countries are now operating with actual hydrogen and PtX strategies because hydrogen-based solutions are seen as necessary in the long term if goals of climate neutrality are to be realised. The challenge today is that PtX fuels are expensive while the industry is continuing to develop. Greenland is in a good position to produce PtX, but there is still a need for the technological processes to reach maturity so that production costs can be reduced, as these fuels are currently not competitive in terms of price in relation to oil and gas.

Biofuels

Biofuels can already be used today in existing internal combustion engines if they are mixed with diesel or petrol (depending on the type of biofuel). There are, however, two significant issues related to biofuels: 1) Sustainability – not all biofuels result in actual CO_2 reductions and 2) Consumption of resources – there are only limited amounts of bioresources available. An estimate (including a margin of uncertainty) is shown of what biofuels and e-fuels are expected to cost as 2050 approaches.

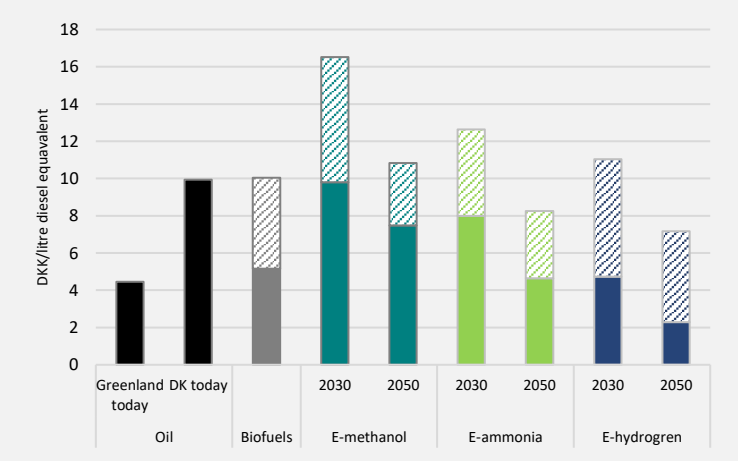


Figure 5. Extrapolated production costs for e-fuels compared to oil prices today. The hatched areas represent a margin of uncertainty. Estimates are based on (IRENA, 2021) (DNV, 2021) (Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, 2021)

[1] Liquified Natural Gas (flydende naturgas)

4

Sector challenges

Recovery of mineral resources

One of the primary reasons for the territorial reservation with respect to the Paris Agreement is a concern as to whether climate considerations may restrict the development of new mineral resource projects that can contribute to economic growth in Greenland.

Activities within the field of mineral resources are under development today and make up less than 1% of Greenland's CO_2 emissions. If the sector develops in a positive manner, however, it may become a game-changer for Greenland's economy, energy demand and potentially also CO_2 emissions. Today there are six active exploitation licences, of which two are active mines. If all the projects covered by the current exploitation licences are realised as mines, this may increase Greenland's carbon footprint by 40% compared to 2020, if the entire electricity demand is provided by diesel generators. What is described here is a worst-case estimate: it should be noted that it is difficult to estimate which projects will be implemented and whether their operating periods, and thus CO_2 emissions, will coincide.

It is possible that mining operations can be based on renewable energy, fuels that inflict less damage on the climate than diesel generators, in addition to which CO_2-reducing technologies can be used. Possibilities include the exploitation of local hydropower resources, hybrid systems with wind turbines, solar cells and batteries, as well as biofuels and e-fuels in the longer term. The Ministry of Mineral Resources deems that there is increasing interest from mining companies in basing energy production on renewable energy sources.

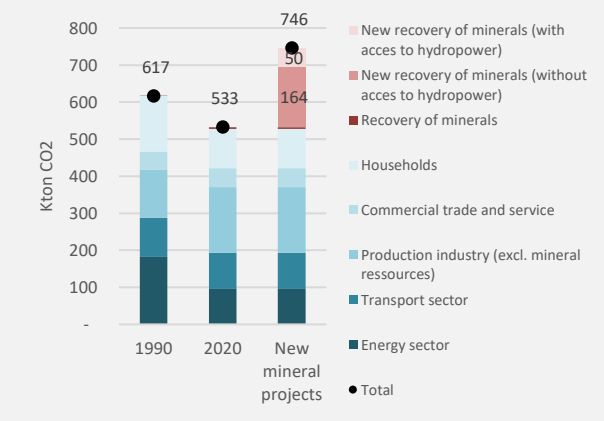


Figure 6: Greenland's CO_2 emissions as a result of energy demand if mines are supplied by diesel generators. Source: Ea Energianalyse based on data input from the Mineral Resources and Justice area.

Shipping and fishery

Fishery is a very important industry in Greenland, with major historical, cultural and commercial importance. In 2020, approximately 20% of Greenland's labour force was employed in fishery, with the country enjoying annual exports of almost DKK 5 billion worth of fish and shellfish products, corresponding to 91% of Greenland's export.

Approximately 300,000 tonnes of fish and shellfish are caught annually. Around half of the fishing takes place from sea-going trawlers, whilst the remainder is coastal, carried out by dinghies, cutters and trawlers.

The green transition is taking place on a global scale, with a significant change expected to occur in the maritime sector during the next few decades. Greenland sells to international markets, where there is growing demand for production that takes impact on the climate into account. It can thus be of benefit to follow international development in order to avoid missing out on commercial opportunities. A scenario for the shipping sector is outlined below in which the targets of the Paris Agreements are met.

Globally, the following trends are deemed to be key in terms of the carbon footprint from the maritime sector:

- There will be a need for a mix of maritime fuels if climate neutrality is to be achieved in 2050
- In the medium term, it will be necessary to increase the energy efficiency of a large section of the maritime fleet if CO_2 emissions are to be reduced
- Experience with e-fuels, including hydrogen, e-methanol and e-ammonia for shipping is limited, but technologies are being developed
- According to IRENA, e-ammonia may be amongst the cheapest green maritime fuels in 2050 if it can be classified as a safe fuel for shipping. It is not yet certain whether ammonia can be deemed as sufficiently safe
- For coastal fishing, electrically propelled vessels may be a possible renewable energy solution
- Liquified natural gas (LNG) is used to a limited extent for shipping today and may play a role in the form of e-methane
- E-diesel appears today to be an expensive solution in the transition of the maritime sector

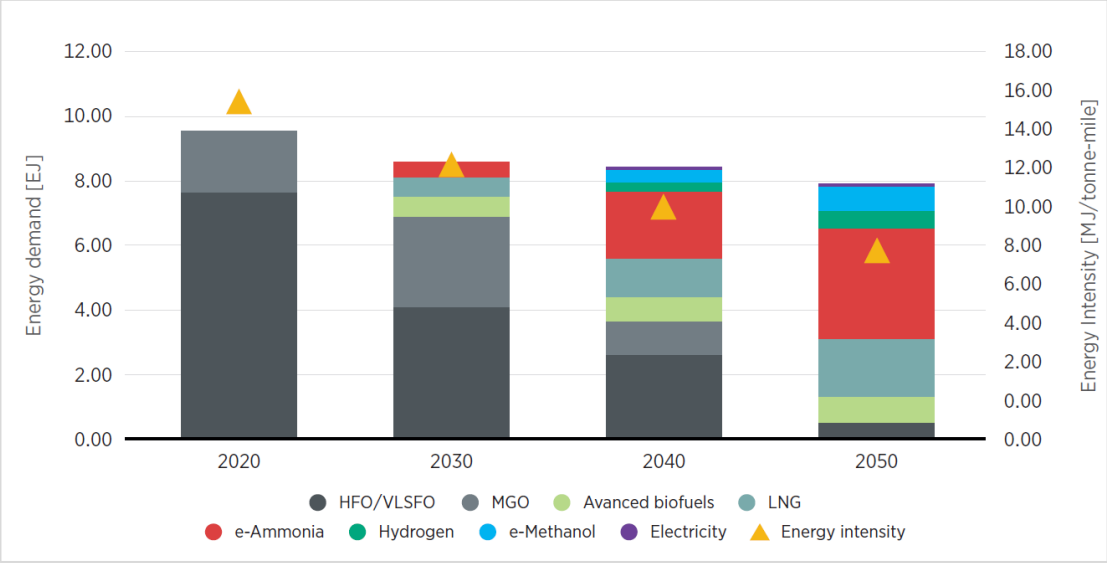


Figure 7. The global maritime energy demand in the '1.5°C scenario' 2018-2050 in IRENA's analysis 'A pathway to decarbonise the shipping sector by 2050', and energy intensity shown per tonne-mile. Source: (IRENA, 2021)

	Availability	Climate	Fuel production	Storage, infra-structure and bunkering	Safety and fuel handling	Regulation
Fossil						
E-hydrogen						
E-ammonia						
E-methanol						
Biofuels						

Figure 8. Green = Mature and tested technology, Yellow = Solution exists, Red = Major challenges. Overview of the status of different types of fuel. Based on (Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, 2021)

In a Greenlandic context, the most important changes within the maritime sector will comprise:

- Improved access to land-based electricity
- Electrification of land transport
- Battery or hybrid solutions for coastal fishing and sections of the fleet
- Electric outboard motors for the dinghy segment
- Advanced biofuels
- E-methanol
- E-ammonia

An overview of the maturity and challenges associated with green fuels for the maritime sector appears in Figure 8.

Other commercial perspectives

In connection with this analysis, the business community in Greenland has been asked as to whether Greenland should revoke the territorial reservation with respect to the Paris Agreement. This knowledge has been acquired through 21 interviews with key operators (see background report for further details), carried out by consultancy firm Mind Your Business. The following is a brief summary based on Mind Your Business' evaluation of the business community's attitude to the Paris Agreement and the green transition:

- The majority of companies interviewed think that it is "the right thing to do" at a time when climate change is on the agenda and the world's attention is focused on the melting of the Ice Sheet
- A frequently mentioned view is that a sustainable tourism strategy for the country is inextricably linked to a national green transition
- Several companies emphasise that the strategic focus on the green transition is to a considerable degree about attracting foreign investors. Production that takes the climate into consideration has thus become 'a game-changer', in particular for the export industry
- There is a clear call from businesses to create politically stable, ambitious and long-term agreements for the green transition, and that these are maintained regardless of which political parties are in government
- Sections of the business community recommend tax structures that favour renewable energy sources and make it less attractive to use fossil fuels. Their view is that there is a need to regulate in a way that generates economic incentives to drive the green transition.

References

DNV. (2021). *Maritime Forecast to 2050 - Energy Transition Outlook 2021.* DNV.

IPCC. (2022). *AR6 Synthesis Report: Climate Change 2022.* Intergovernmental Panel on Climate Change (IPCC).

IRENA. (2021). *A pathway to decarbonise the shipping sector.* International Renewable Energy Agency (IRENA).

Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. (2021). *We show the world it is possible.* Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping.

UNFCCC. (2022). *Nationally determined contributions under the Paris Agreement - Synthesis report by the secretariat.* United Nations - Framework Convention on Climate Change.

United Nations. (2022, 11). *United Nations - Climate Action*. Retrieved from www.un.org: https://www.un.org/en/climatechange/what-is-climate-change